

a deformation field from a pair of images. These include not only the disclosed RegNet+STN combination structure, but also linear or U-Net structures or different combinations of basic neural network elements such as convolution operations, activation functions, max pooling and batch normalization.

**[0106]** The disclosed method and system provide enhanced speed, robustness, and simplicity with motion vectors between two gates being produced. The disclosed techniques can lead to a significant reduction in computational cost as compared to commonly used image registration techniques that are computationally very intensive in order to produce realistic motion vectors. Once the neural network is trained, it will rapidly produce motion vectors. This approach will also greatly increase flexibility as one can change the reference gate and quickly obtain the motion vectors instead of running a full new set of registration techniques. This approach also allows for joint motion vector and activity estimation inside a neural network.

**[0107]** As discussed above, the method and system described herein can be implemented in a number of technologies but generally relate to imaging device and/or processing circuitry for performing the motion compensation described herein. In one embodiment, the processing circuitry is implemented as one of or as a combination of: an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a generic array of logic (GAL), a programmable array of logic (PAL), circuitry for allowing one-time programmability of logic gates (e.g., using fuses) or reprogrammable logic gates. Furthermore, the processing circuitry can include computer processor circuitry having embedded and/or external non-volatile computer readable memory (e.g., RAM, SRAM, FRAM, PROM, EPROM, and/or EEPROM) that stores computer instructions (binary executable instructions and/or interpreted computer instructions) for controlling the computer processor to perform the processes described herein. The computer processor circuitry may implement a single processor or multiprocessors, each supporting a single thread or multiple threads and each having a single core or multiple cores. To reiterate, in an embodiment in which neural networks are used, the processing circuitry used to train the artificial neural network need not be the same as the processing circuitry used to implement the trained artificial neural network that performs the motion compensation described herein. For example, processor circuitry and memory may be used to produce a trained artificial neural network (e.g., as defined by its interconnections and weights), and an FPGA may be used to implement the trained artificial neural network. Moreover, the training and use of a trained artificial neural network may use a serial implementation or a parallel implementation for increased performance (e.g., by implementing the trained neural network on a parallel processor architecture such as a graphics processor architecture).

**[0108]** In the preceding description, specific details have been set forth. It should be understood, however, that techniques herein may be practiced in other embodiments that depart from these specific details, and that such details are for purposes of explanation and not limitation. Embodiments disclosed herein have been described with reference to the accompanying drawings. Similarly, for purposes of explanation, specific numbers, materials, and configurations have been set forth in order to provide a thorough under-

standing. Nevertheless, embodiments may be practiced without such specific details. Components having substantially the same functional constructions are denoted by like reference characters, and thus any redundant descriptions may be omitted.

**[0109]** Various techniques have been described as multiple discrete operations to assist in understanding the various embodiments. The order of description should not be construed as to imply that these operations are necessarily order dependent. Indeed, these operations need not be performed in the order of presentation. Operations described may be performed in a different order than the described embodiment. Various additional operations may be performed and/or described operations may be omitted in additional embodiments.

**[0110]** Those skilled in the art will also understand that there can be many variations made to the operations of the techniques explained above while still achieving the same objectives of the invention. Such variations are intended to be covered by the scope of this disclosure. As such, the foregoing descriptions of embodiments of the invention are not intended to be limiting. Rather, any limitations to embodiments of the invention are presented in the following claims.

What is claimed is:

1. A method of generating a motion compensation system comprising:
  - obtaining a series of images including movement of at least one object between the series of images; and
  - training a machine learning-based system based on the series of images to produce a trained machine learning-based system for providing at least one motion vector indicating a movement of the at least one object between the series of images.
2. The method as claimed in claim 1, wherein the training comprises minimizing a penalized loss function based on a similarity metric.
3. The method as claimed in claim 2, wherein the similarity metric comprises a cross correlation function for correlating plural images of the series of images.
4. The method as claimed in claim 1, wherein the series of images comprises a moving image and a fixed image, and wherein the training comprises warping the moving image to the fixed image using a differentiable spatial transform.
5. The method as claimed in claim 1, wherein the machine learning-based system comprises a neural network and the trained machine learning-based system comprises a trained neural network.
6. The method as claimed in claim 1, wherein the machine learning-based system comprises a neural network and the trained machine learning-based system comprises a trained neural network, and
  - wherein the trained neural network comprises the neural network trained using unsupervised training.
7. The method as claimed in any claim 1, wherein the machine learning-based system is trained using PET data.
8. The method as claimed in claim 1, where in the machine learning-based system is trained using gated PET data.
9. A trained machine learning-based system produced according to the method of claim 1.
10. A system for generating a motion compensation system comprising: